LITTLE MOUNTAIN
P8279

Ballantine

INSTRUCTION MANUAL

MODEL 3205A DIGITAL MICRO-OHMMETER

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90103005A

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WARRANTY

This Ballantine Laboratories, Inc. product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except for batteries, electron tubes, vacuum thermocouples, and certain other components, if any, listed in this manual. Ballantine Laboratories, Inc. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Ballantine Laboratories, Inc. prepaid, and provided the proper preventive maintenance and calibration procedures as listed in this manual have been followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BALLANTINE LABORATORIES, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES. This warranty does not include the probe detector diodes.

CERTIFICATION

Ballantine Laboratories, Inc. certifies that this equipment meets all applicable Ballantine specifications at time of shipment from the factory as determined by thorough testing and inspection. Ballantine further certifies that its measurements are traceable to the United States National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.

REFERENCE STANDARDS

DC	10mV-750V	0.01-0.04%
20Hz-50kHz	0.5V-500V	0.03%
20Hz-10MHz	0.5V-100V	0.1%
DC-30MHz	0.5V-100V	0.5%
DC-700MHz	10μV-0.5V	1%–NBS
10MHz-1000MHz	1V-300V	1%–NBS

WORKING STANDARDS

TRANSFER VM BALLANTINE, 1600A
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH

CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS

LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS

LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS

LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfied the requirements of MIL-I-45208

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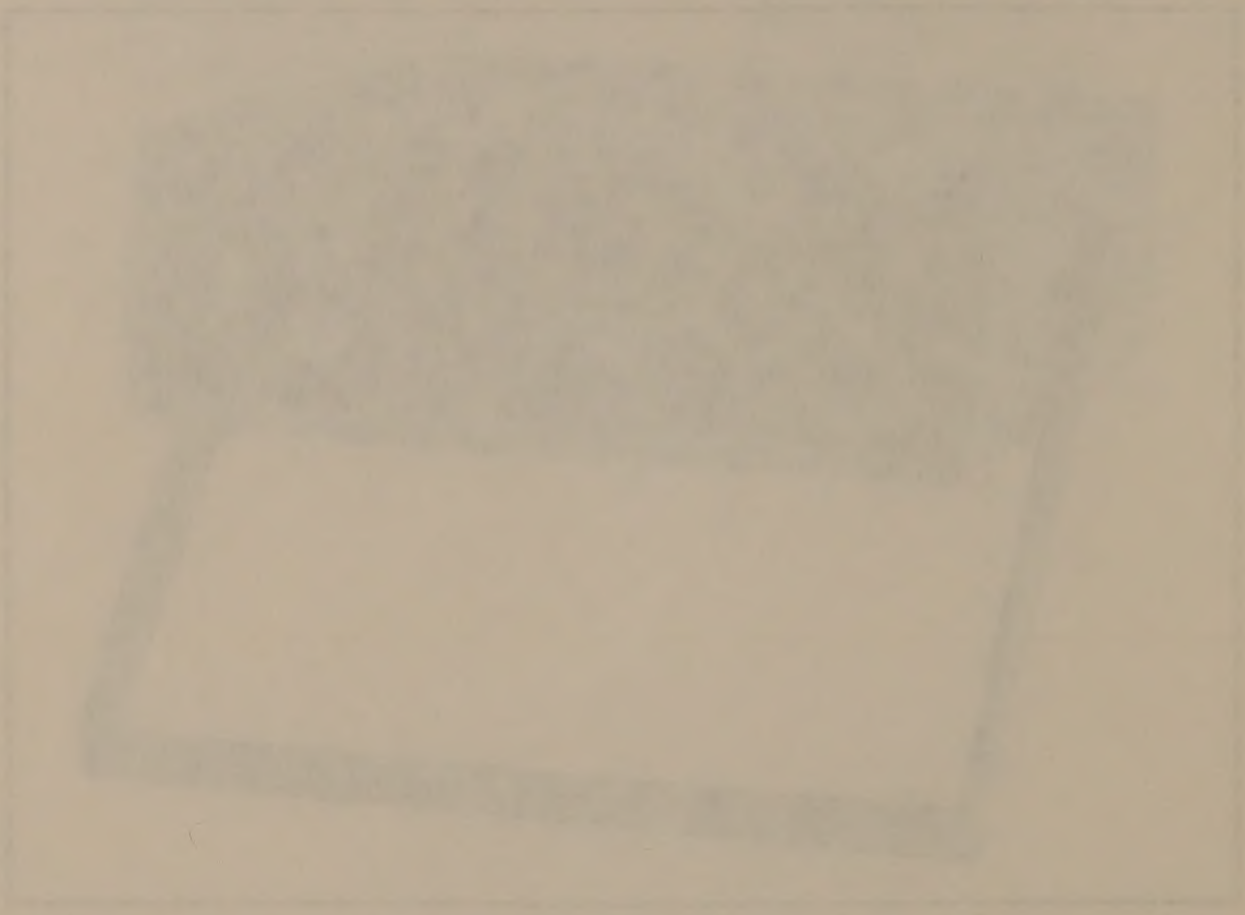
LITTLE MOUNTAIN

Figure 1-1. Model 3205A Digital Micro-Ohmmeter



SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. The Ballantine Model 3205A is a fully portable digital micro-ohmeter capable of measuring low resistance with micro-ohm resolution. It employs the proven 4 wire method to eliminate the effect of lead resistance on the accuracy of measurement. It is a highly reliable instrument incorporating proven LSI circuits and stable components. It is a direct reading instrument leading to simple, speedy and accurate measurements. It overcomes the operational difficulties of conventional bridge measurements and may be used in automated test stations when the BCD data ouput option is installed.

1-3. The 3 1/2 digit LED display with automatically positioned decimal point is bright and easy to read. The readout is direct in terms of Ω/mΩ as selected by front panel switch. In Ω display mode, the resolution is 1 milliohm and in mΩ display mode, it is 1 micro-ohm.

1-4. SPECIFICATIONS

1-5. See table 1-1 for a full list of specifications.

1-6. ACCESSORIES

1-7. Standard Accessories

1 test lead set with Kelvin contact clips.

1-8. Optional Accessories

Ballantine 2488A Instrument Coupler:

Interfaces TTL compatible instruments with IEEE 488-1978 Bus. Operates as talker, listener, or both. In any operating mode, the 2488A acts as a transparent device.

1-9. OPTIONS

OPTION 01: Data Output

Parallel BCD format outputs status of digits, polarity, and decimal point. All outputs can drive one TTL load (maximum).

TABLE 1-1. SPECIFICATIONS

FUNCTIONAL:

Range	Resolution	ACCURACY ± (% Range + % Rdg.)	Full Scale Reading	Current Applied (mA)	Power Dissipation in the Sample at Half Scale (mW) (1000 counts)
2 mΩ	1 uΩ	± (0.3 + 0.2)	1.999 mΩ	1000	1
20 mΩ	10 uΩ	± (0.3 + 0.2)	19.99 mΩ	100	0.1
200 mΩ	100 uΩ	± (0.3 + 0.1)	199.9 mΩ	10	0.01
2 Ω	1 MΩ	± (0.3 + 0.1)	1.999 Ω	10	0.1
20 Ω	10 MΩ	± (0.3 + 0.1)	19.99 Ω	1	0.01
200 Ω	100 MΩ	± (0.3 + 0.1)	199.9 Ω	0.1	0.001

Above accuracies apply at 25°C from 10% of full scale to full scale.
The temperature co-efficient of accuracy: ± (150 ppm of reading)/°C

TABLE 1-1. SPECIFICATIONS - Cont'd

MODES OF OPERATION:		
CONT	:	Read rate approximately 2 reading/sec.
PULSE	:	Test current is pulsed when MEASURE pushbutton is depressed. Display is stored until next pushbutton action. Current pulse duration approximately 1.2 seconds.
DISPLAY:		
Type	:	3 1/2 digits, long life LED, 7 segment numerals, 0.5" high, non-blinking bright red.
Decimal Point	:	Decimal point is automatically positioned and displayed.
Zero	:	Front panel screwdriver adjustment.
Overload Indication	:	Display blinks above 1999 counts in CONT mode and blanks out above 1999 counts in PULSE mode.
INPUT CIRCUIT:		
Input Configuration	:	4 wire; 2 for voltage, 2 for current.
Input Connectors	:	Universal binding posts permit use of seven locked lugs, wires, or banana plugs.
Compliance Voltage	:	1 volt; nominal.
INPUT PROTECTION:		
Voltage Terminals	:	Electrically protected to 250 volts sinusoidal or 300 volts peak ac + dc.
Current Terminals	:	Fuse protected by 1 ampere fuse accessible at the rear panel.
ENVIRONMENTAL:		
Temperature	:	Operating: +10°C to +45°C Storage: -40°C to +75°C
Humidity	:	Operating: 80% R.H. to 40°C No condensation permitted.
GENERAL:		
Dimensions	:	Height: 76 mm (3 1/6") Width : 222 mm (8 3/4") with handle Depth : 273 mm (10 3/4") with handle
Weight	:	2.77 Kg (6 lbs. 1 oz.)
Shipping Weight	:	4.75 Kg (9 lbs. 9 oz.)
Power	:	AC mains voltage supply. Selection of two operating voltage ranges provided by slide switch on the rear panel. 90 V to 132 V; AC (sinusoidal); 50 Hz to 400 Hz 198 V to 264 V; AC (sinusoidal); 50 Hz to 400 Hz Power consumption: 30 watts

TABLE 1-1. SPECIFICATIONS - Cont'd

ACCESSORIES:		
Supplied	:	One test lead set with Kelvin contact clips (P/N 85-60196-0) One AC mains power cable (P/N 33-10000-0)
Optional	:	Ballantine 2488A Instrument Coupler for IEEE-488 Interface
OPTIONS:		
Option 01	:	Data Output. Parallel BCD format output status of digits, polarity, and decimal points will drive one TTL load.

SECTION 2

INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information and instructions necessary for the installation of the instrument. Details are provided for initial inspection, power requirement, safety installation, and repackaging information.

2-3. UNPACKING AND INITIAL INSPECTION

2-4. Unpacking and initial inspection of the instrument require only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents should be checked for included accessories and any damages that might have occured during transit.

2-5. PERFORMANCE CHECKS

2-6. This instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in perfect electrical order upon receipt. Check the instrument for possible damage incurred during transit, and if necessary, carry out performance checks outlined in paragraph 5-7 of Section 5 in this manual. If there is any indication of damage or improper operation, refer to the warranty included in this manual and notify your local representative or the factory.

2-7. SAFETY REQUIREMENTS

2-8. See Table 2-1 for the basic applicable safety requirements.

2-9. ALWAYS observe these safety considerations and cautions. Read and understand all of this manual for operational considerations and operator safety.

2-10. POWER REQUIREMENT

2-11. This equipment is designed to operate on ac mains and has 2 voltage ranges. It can operate either from 90 V to 132 V or 198 V to 264 V. The range can be selected by AC Mains Selector Switch located on the rear panel.

2-12. Insert the ac mains power cable supplied with the instrument into the ac mains input socket located below the AC Mains Selector Switch on the rear panel. Check that the proper mains fuse is installed. Connect the instrument to ac supply of 50 Hz to 400 Hz. Check voltage range switch setting and mains fuse. Also, check the input protection 1 Amp fast blow fuse located on the rear panel below the mains fuse.

CAUTION

DO NOT USE AC MAINS VOLTAGE OTHER THAN THAT SELECTED AND SPECIFIED ABOVE SINCE IT MAY RESULT IN DAMAGE TO THE INSTRUMENT AND VOID THE WARRANTY.

2-13. The instrument should be operated from an ac power source with its neutral at or near ground (earth) potential. The instrument is not intended for operation from two phases of a multiphase ac system across the legs of a single-phase, three-wire system. Crest factor (ratio of peak voltage to rms) should be typically within the range of 1.3 to 1.6 at ± 10% of the nominal rms line voltage. Use a true rms responding voltmeter, such as the Ballantine Model 3620A, to measure the power line voltage.

WARNING

The instrument is provided with a three-connector power cord which will ground the case when connected to a three-connector grounding outlet. If a grounding outlet is not available, an adapter must be used which provides a good grounding connection.

2-14. GROUNDING REQUIREMENTS

2-15. To insure the safety of operating personnel, the U.S. Occupational Safety and Health Act (OSHA) and good engineering practice require that the instrument panel and enclosure be "earth grounded". All Ballantine instruments are provided with a three-conductor power cable assembly which, when plugged into an appropriate power receptacle, grounds the instrument. The offset pin on the male end of the power cable is the ground wire connection to the connector on the rear panel of the instrument.

2-16. To preserve the safety protection feature, when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead or terminal on the adapter to "earth ground".

TABLE 2-1.

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Ballantine Laboratories assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to Ballantine Laboratories Service Department for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument.
Use extreme caution when handling, testing, and adjusting.

2-17. INSTALLATION

2-18. The instrument is fully solid state and dissipates minimum heat and no special cooling is required. However, the instrument should not be used where ambient environment is beyond the temperature limits given in the specifications (see table 1-1). The instrument is shipped ready for use as a portable or bench instrument. Outline dimensions of the case are shown in figure 2-1.

NOTE

Before using the instrument, exercise each of the pushbutton switches six or more times. This wiping action cleans switch contacts which may become noisy or intermittent during periods of storage or in contaminating environments.

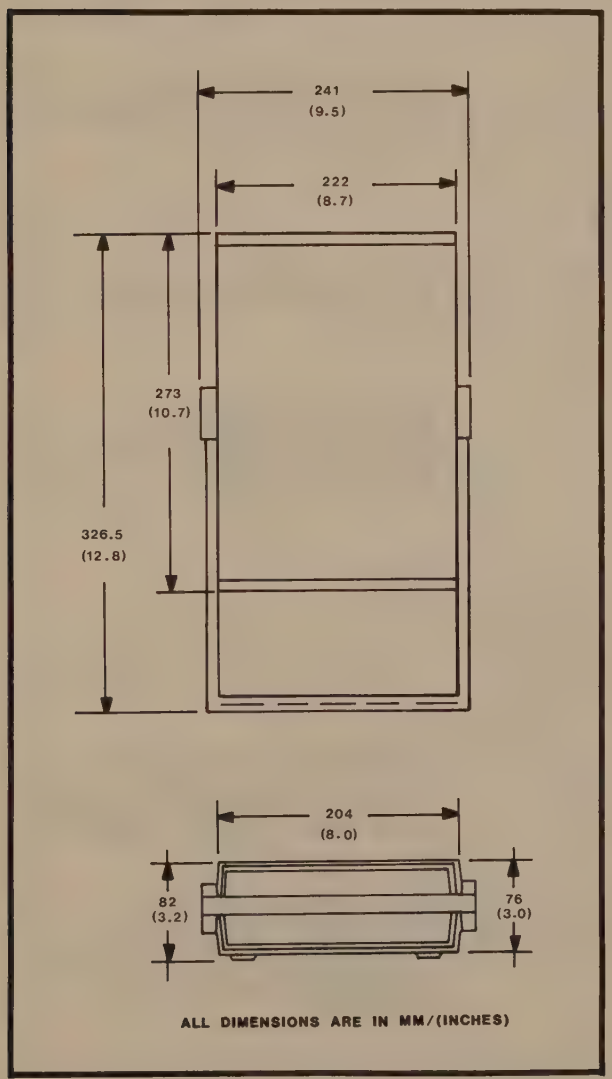


Figure 2-1. Model 3205A Outline Dimensions

2-19. The instrument case is provided with a carrying handle which also serves as a tilt stand. To change the position of the handle, simply pull both sides of the handle outward from the case to disengage detent mechanism, then rotate the handle to desired position, push the handle back towards the case and rotate slightly until it detents in place. However, it is not possible to remove handle without opening the instrument enclosure.

2-20. REPACKAGING FOR SHIPMENT

2-21. If the instrument is to be repackaged for shipment, as a general guide, repackage the instrument as described in the following procedure and as shown in Figure 2-2. Use either the original packing material, if available, or material similar to that specified. Proceed as follows:

a. Place the instrument accessories, if any, in a plastic bag and seal the bag.

b. For long distance shipping only, use U.S. Government packaging method IIC and tape a two-unit bag of dessicant (MIL-D-3464) on the rear of the enclosure.

c. Place a piece of sturdy cardboard over the front panel for protection. Enclose the instrument in a plastic bag and seal the bag.

d. Wrap the bagged instrument and accessories in 1-inch thick, flexible, cellular plastic-film, cushioning material (PP-B-795) and place in a barrier bag (MIL-B-131). Extract the air from the bag and heat seal.

e. Place the wrapped instrument and accessories into a fiberboard box (PPP-B-636) of suitable size. Fill spaces with rubberized hair or cellular plastic cushioning material. Close box in accordance with container specifications. Seal with sturdy water-resistant tape or with metal straps.

f. Mark contained "FRAGILE", "HANDLE WITH CARE", or similar precautionary notice. Affix shipping labels as required or mark according to MIL-STD-129.

NOTE

If the instrument is to be shipped to Ballantine for calibration or repair, attach a tag to the instrument identifying the owner. Note the problem, the symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the work authorization order as well as the date and method of shipment. Always obtain a RETURN AUTHORIZATION from the factory before shipping the instrument.

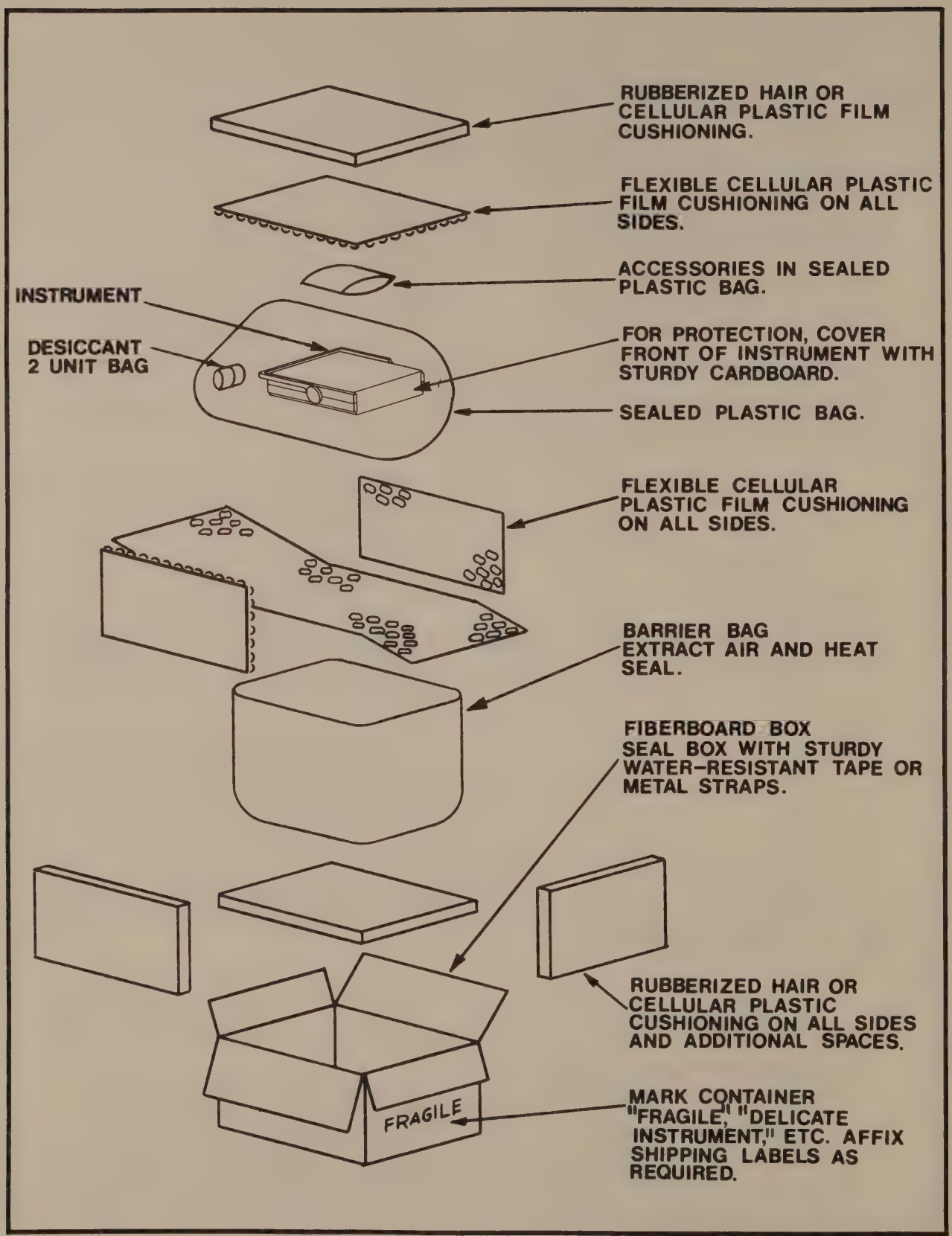

RUBBERIZED HAIR OR CELLULAR PLASTIC FILM CUSHIONING.
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING ON ALL SIDES.
ACCESSORIES IN SEALED PLASTIC BAG.
INSTRUMENT
DESICCANT 2 UNIT BAG
FOR PROTECTION, COVER FRONT OF INSTRUMENT WITH STURDY CARDBOARD.
SEALED PLASTIC BAG.
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING ON ALL SIDES.
BARRIER BAG EXTRACT AIR AND HEAT SEAL.
FIBERBOARD BOX
SEAL BOX WITH STURDY WATER-RESISTANT TAPE OR METAL STRAPS.
RUBBERIZED HAIR OR CELLULAR PLASTIC CUSHIONING ON ALL SIDES AND ADDITIONAL SPACES.
FRAGILE
MARK CONTAINER "FRAGILE," "DELICATE INSTRUMENT," ETC. AFFIX SHIPPING LABELS AS REQUIRED.

Figure 2-2. Packing Diagram

SECTION 3

OPERATION

3-1. INTRODUCTION

3-2. This section contains instructions and information required for the operation of the Ballantine Model 3205A Digital Micro-Ohmmeter. Included are identification of controls, indicators, and connectors as well as turn on procedures and operating instructions.

3-3. CONTROLS, INDICATORS, AND CONNECTORS

3-4. The instrument controls, indicators, and connectors are identified in figure 3-1 and 3-2 and described in table 3-1.

3-5. OPERATING HINTS

3-6. Be sure you apply the proper AC mains voltage. Check whether AC mains Selector Switch is set properly.

CAUTION

DO NOT USE AC MAINS VOLTAGE OTHER THAN THAT SPECIFIED. OTHERWISE YOU MAY DAMAGE THE INSTRUMENT AND VOID THE WARRANTY.

3-7. Depress the ON/OFF switch to switch on the instrument. Power ON will be indicated by a lighted display. Allow the instrument to warm up for approximately 15 minutes.

3-8. Depress the ZERO/OPERATE switch. The display should read 000. If not, adjust the reading to zero using a screwdriver through the cutout in the front panel.

3-9. Measurements can be made either in CONTinuous mode or PULSE mode. In CONTinuous mode, current is continuously applied to the sample under measurement. In the PULSE mode, current is applied only for a short duration. This helps to avoid heating the resistance being measured. All the following operating procedures are described for CONTinuous mode measurements. Refer to paragraph 3-20 for PULSE mode measurements.

3-10. The instrument is supplied with copper leads. If it is required to use leads other than the ones supplied with the instrument, they should also be made of copper. Otherwise thermal e.m.f. may develop and cause the following problems.

a. Readings may become unstable.

b. Zero offset may become high and can not be nulled by ZERO adjustment.

c. Instrument becomes sensitive to ambient temperature differences.

3-11. To reduce thermal e.m.f. errors use the following procedures.

a. If the thermal e.m.f. is constant, it can be compensated by adjusting the ZERO adjust provided on the front panel. The thermal e.m.f. can be determined by connecting only the voltage leads. After ZERO adjustment, connect the current leads and make the actual resistance measurement.

b. Take measurements with current terminals connected in normal position as well as reversed position. The average of these two measurements can be taken as the true value. This method minimizes the effect of thermal e.m.f.

3-12. Compliance voltage is defined as the maximum voltage burden that can be generated by the constant current applied to the load without affecting the constant current accuracy. This puts a limit on the resistance of the leads which can be used for measurement of resistance. If current leads other than the ones provided with the instrument are to be used, use copper leads having a total resistance of less than 0.5 ohms.

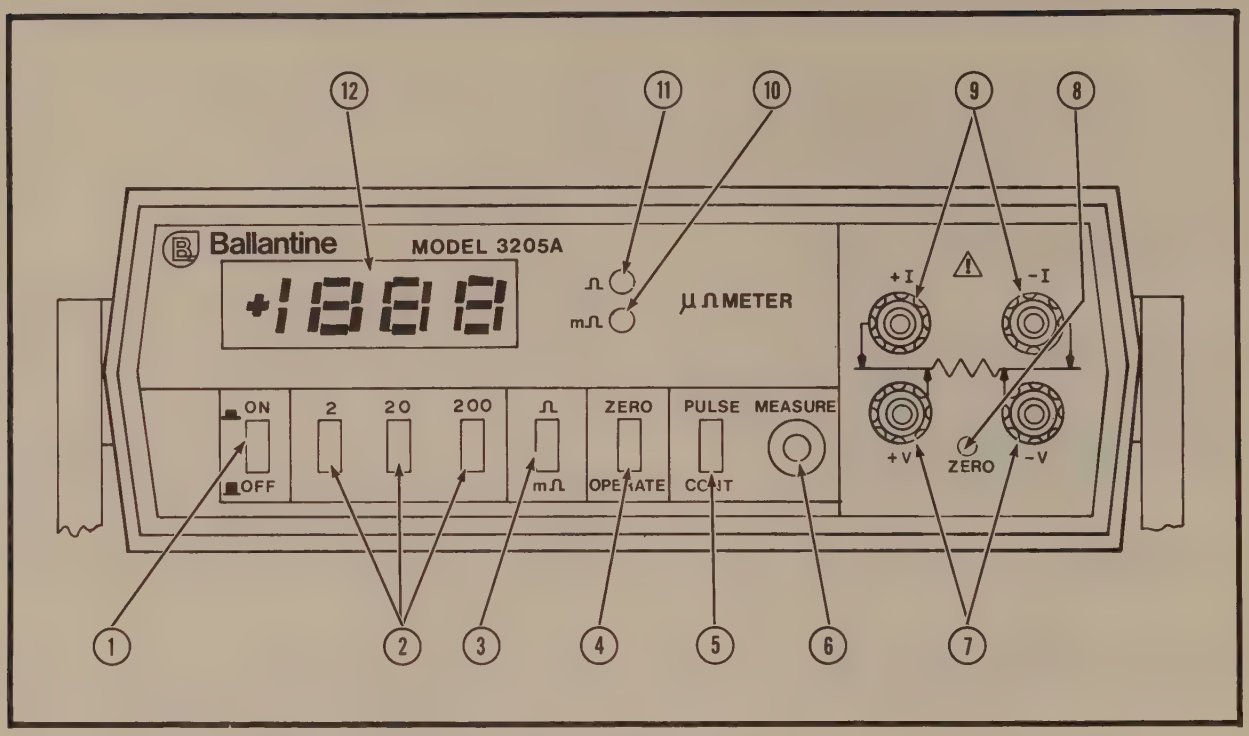


Figure 3-1. Front Panel Controls, Indicators, and Connectors

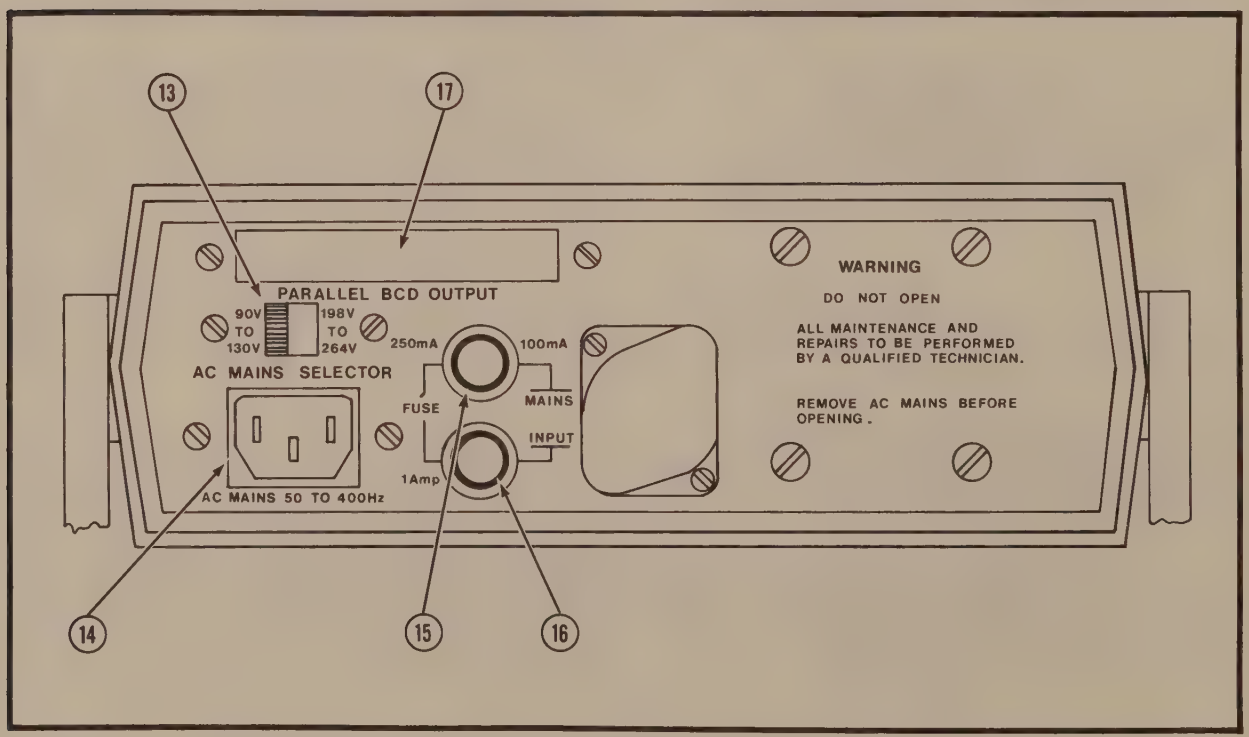


Figure 3-2. Rear Panel Controls, Indicators, and Connectors

TABLE 3-1. CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO.	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
1	ON/OFF Switch	Pushbutton switch to turn the instrument ac mains power ON when pressed and OFF when released.
2	2/20/200 Range Selector Switch	3 position gang switch used to select appropriate range of resistance under measurement. "2" switch selects 2 Ω/2 mΩ range when pressed. "20" switch selects 20Ω/20 mΩ when pressed. "200" switch selects 200Ω/200 mΩ range when pressed. These are selected in conjunction with Function Selector Switch Ω/mΩ.
3	Ω/mΩ Selector Switch	Pushbutton switch to select Ω/mΩ function. Selects Ω (ohms) when pressed. Selects mΩ (milliohms) when released.
4	ZERO/OPERATE Switch	Pushbutton switch selects ZERO adjust mode when pressed and OPERATE mode when released.
5	PULSE/CONTinuous Switch	Pushbutton switch selects PULSE mode when pressed and CONTinuous mode when released.
6	MEASURE Microswitch	Pushbutton microswitch to trigger PULSE mode operation. To be pressed only for a fraction of a second.
7	Voltage Terminals (+V, -V)	Input terminals used to measure voltage across the resistance being measured.
8	ZERO	ZERO adjust screwdriver preset is accessible through the front panel and is used to zero the display.
9	Current Terminals (+I, -I)	Output terminals used to send constant current through the resistance under test.
10	mΩ LED Indicator	LED lights when Ω/mΩ switch is released, indicating selection of mΩ function.
11	Ω LED Indicator	LED lights when Ω/mΩ switch is pressed, indicating selection of Ω function.
12	LED Display	3 1/2 digit LED display with automatic positioning of decimal point indicating the magnitude of resistance under measurement. The unit of measurement is indicated by Ω/mΩ LED indicator (Index No. 10 & 11).
13	AC Mains Selector Switch	To select appropriate ac mains voltage input. Selects 90 V to 132 V when pushed left and 198 V to 264 V when pushed right.
14	AC Mains Receptacle	Receptacle to ac mains input power cable.
15	Mains Fuse	Fuse holder to hold mains fuse.
16	Input Protection Fuse	Fuse holder for the current leads protection fuse. Use 1 Amp fast blow fuse.
17	Parallel BCD Output	Output from the instrument is available in parallel BCD format. Printed wiring board edge connector mates with 44 pin receptacle Ballantine P/N 31-10365-0 used with 44 conductor cable Ballantine P/N 79-10133-0.

3-13. CIRCUIT CONNECTIONS

3-14. When measuring a resistance of the order of a few milliohms, it is necessary to make proper connections to avoid errors. This instrument uses the 4 wire method to eliminate the error due to resistance of the leads. Therefore, it is necessary to connect the voltage leads and current leads as shown in figure 3-3. Figures 3-4 and 3-5 illustrate incorrect connections.

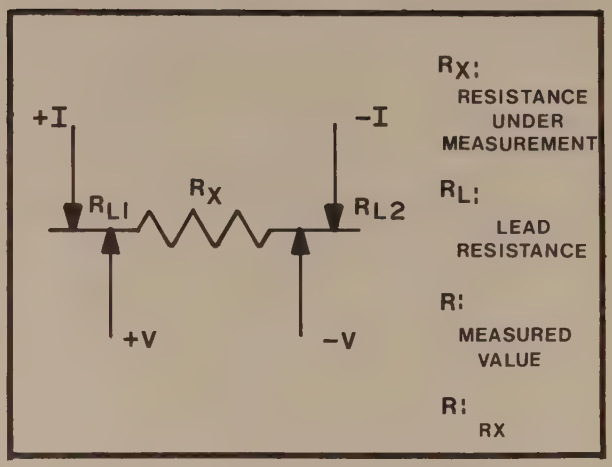


Figure 3-3. Correct 4 Wire Measurement Method Connection

CAUTION

Before making a measurement, please refer to the table of applied currents given in the specifications. Be certain that the current applied/power dissipated is within the safe operating limits of the resistance under test. To reduce power dissipation in non-inductive samples, please refer to 3-20 of this section on PULSE mode operation.

3-15. MEASUREMENT

3-16. MEASUREMENT OF RESISTANCE IN THE MILLIOHM RANGE

3-17. Three milliohm ranges are provided. They are:

1. 2 mΩ range (display .000 to 1.999)
2. 20 mΩ range (display 0.00 to 19.99)
3. 200 mΩ range (display 00.0 to 199.9)

a. Switch the instrument ON by pressing the ON/OFF switch.

b. Select the mΩ function by releasing the Ω/m button.

c. Select the appropriate range by pressing one of the 2/20/200 RANGE switches. Connect the resistance to be measured as shown in figure 3-3.

d. Release the ZERO/OPERATE switch to enable the OPERATE mode.

e. If the range selected is such that the maximum value of the range is less than the value being measured, the display starts to indicate an overrange condition. Select the next higher range. The maximum value that can be measured is 199.9 milliohms.

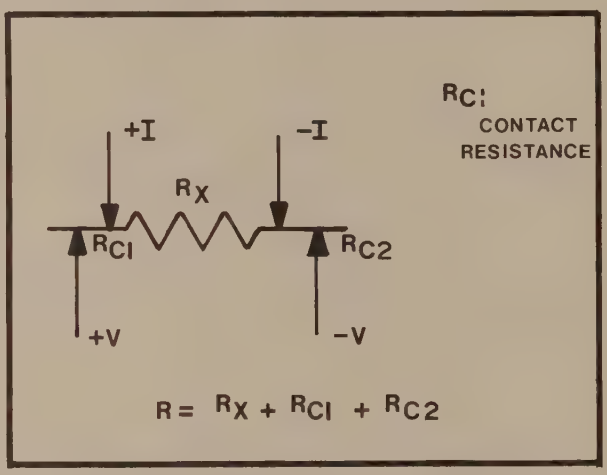


Figure 3-4. Incorrect 4 Wire Measurement Method Connection

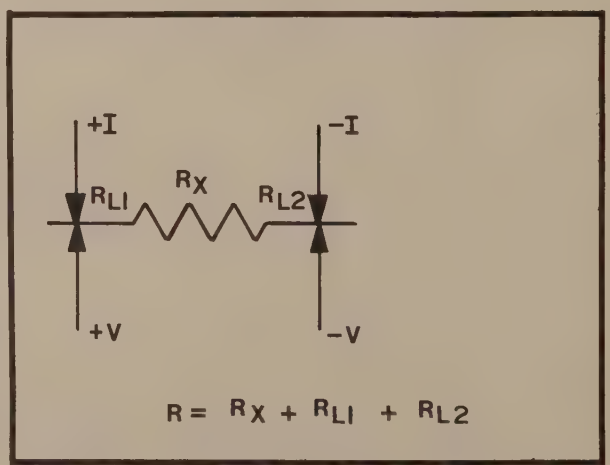


Figure 3-5. Incorrect 4 Wire Measurement Method Connection

3-18. MEASUREMENT OF RESISTANCE IN OHMS RANGE

3-19. Three possible ohm ranges are provided. They are:

1. 2 Ω range (display .000 to 1.999)
2. 20 Ω range (display 0.00 to 19.99)
3. 200 Ω range (display 00.0 to 199.9)

a. Select the function switch to Ω by pressing the Ω/mΩ switch.

b. Select appropriate range by pressing one of the 2/20/200 RANGE switches.

c. Connect the resistance to be measured as shown in figure 3-3.

d. Release ZERO/OPERATE switch to enable OPERATE mode.

e. If the value being measured is greater than the maximum reading of the range selected, then the display will blink. Select the next higher range. The maximum value that can be measured is 199.9 ohms.

NOTES

a. The maximum value of resistance that can be measured by this instrument is 199.9 ohms. Any value higher than the above mentioned value will be indicated by a blinking display and can not be measured. Use a Digital Multimeter such as the Ballantine 3028B or 3036A when resistance measurements to 20 megohms are required.

b. The resolution on the lowest range (2 mΩ range) is 1 microhm.

c. For best resolution select the range indicating the greatest number of digits on the LED display.

d. When measuring an unknown resistance, always start from the highest range, i.e. 200 Ω range, and then select the appropriate lower range.

CAUTION

ALWAYS TURN OFF ALL POWER FROM THE RESISTANCE UNDER TEST. DO NOT CONNECT THE CURRENT OR VOLTAGE LEADS OF THE INSTRUMENT TO ANY CURRENT CARRYING SOURCE SINCE THIS MAY RESULT IN DAMAGE TO THE INSTRUMENT AND VOID THE WARRANTY.

3-20. PULSE MODE OPERATION

3-21. In this mode, current through the resistance is applied only for a short duration, and the reading is stored till the next measurement cycle is initiated. This results in minimum heating of the resistance under test. PULSE mode operation permits accurate measurement of resistances which are temperature dependent. It is useful for non-destructive measurement of fuse links, riveted joints, welds, solder joints, relays and switch contacts, etc.

3-22. OPERATION

a. Depress the PULSE/CONTinous mode switch to select PULSE mode operation.

b. Select appropriate range multiplier by pressing or releasing the Ω/mΩ switch.

c. Select appropriate range by pressing one of the 2/20/200 RANGE switches.

d. Release ZERO/OPERATE switch to enable the OPERATE mode.

e. Depress the MEASURE microswitch for a fraction of a second.

f. Reading will be displayed.

g. If the display blanks, select the next higher range and repeat steps b. through f. above.

CAUTION

PULSE MODE OPERATION MUST BE USED ONLY FOR NON-INDUCTIVE RESISTORS. UNDER NO CIRCUMSTANCES SHOULD IT BE USED TO MEASURE INDUCTIVE RESISTANCES. OTHERWISE YOU MAY OBTAIN ERRONEOUS READINGS AND/OR DAMAGE THE INSTRUMENT.

3-23. MEASUREMENT OF INDUCTIVE RESISTANCES

3-24. To measure highly inductive resistances, the following procedure using the CONTinuous mode should be followed.

a. Press ZERO/OPERATE switch to enable the ZERO mode.

b. Connect the current terminal to the resistance under test.

c. Select the appropriate range and function.

d. Release ZERO/OPERATE switch to enable OPERATE mode.

e. Allow 5 minutes for the measurement current to settle to final value.

f. Connect the voltage leads.

g. Observe the reading.

h. Remove the voltage leads.

i. Short the voltage leads of the resistance under test with a heavy shorting wire. Allow 5 minutes to discharge the load.

j. Depress the ZERO/OPERATE switch to enable the ZERO mode.

k. Remove the current leads after the inductive resistance is fully discharged.

CAUTION

This shorting of the inductive resistor under test procedure must be followed to avoid damage to the instrument caused by the energy stored in the inductor being discharged through the instrument.

l. If the reading is less than 10% of the full scale, select the next lower range and follow the same procedure, from a. to k.

m. If the instrument over-ranges, then select the next higher range and follow the same procedure given above, from a. to k.

NOTE

This procedure is to be followed especially while measuring transformer winding resistance, of large power transformers in the order of 1 MVA and above or in motor windings. When the inductive resistances under test are adjacent to high tension ac generation and transmission equipment, they are likely to pick up noise which may result in unstable readings. This instrument is specially designed to reject unwanted pick up. Inspite of this, if the display instability is found to be excessive, remove the source of noise before making a measurement. Also, due to limited compliance voltage and current, the time required to obtain a steady reading is substantial when making winding resistance measurements on transformers of capacities higher than 8 MVA. When fast responding resistance measurements are to be made on highly inductive loads, use of specially designed equipment is recommended.

SECTION 4

THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section of the manual contains a description of the circuitry used in this instrument. Figure 4-1 is a detailed block diagram of the instrument. Basically, it contains 5 functional areas. These are the power supply circuit, current source circuit, voltage amplifier circuit, analog to digital conversion circuit, and display circuit.

4-3. PRINCIPLE OF OPERATION

4-4. A constant current source drives a predetermined current through the resistance being measured and develops a voltage across the resistance. The magnitude of the current is fixed for a given range of the instrument (See table 1-1 for specification). The voltage developed across the resistance is then amplified by a voltage amplifier to make it compatible with the sensitivity of the A/D converter. The A/D converter converts the analog signal into a digital signal which is displayed by the instrument. The input circuit of the instrument consists of four terminals. Since separate terminals are used for measuring voltage drop across the resistance being measured, the drop in the current leads is not part of the measurement.

4-5. CURRENT SOURCE

4-6. The constant current source is comprised of IC5, darlington pair Q1 and Q2, and reference diode D13; as well as scaling resistances R28, R31, R34, R37, and R40. A fixed reference is applied to the non-inverting pin of op-amp IC5 and to the front panel current terminals because of the closed loop through Q1 and Q2, the load and scaling resistors. The reference is adjusted to 1 V with the help of trimmer R26. Therefore, the current through the load is constant and its magnitude is dependent on the scaling resistors. For different ranges, a different scaling resistor is connected resulting in the appropriate constant measuring current.

4-7. VOLTAGE AMPLIFIER

4-8. This amplifier consists of IC1 and resistances R2, R3, R4, R5, R6, and other components. Amplifier IC1 is chopper stabilized. The signal developed across the resistance being measured is very small and therefore the amplifier must be highly stable and drift free. IC1 is a very low drift and low noise chopper stabilized amplifier having two gain settings. In mΩ position of mΩ/Ω switch, the op-amp has a gain of 100 and in the Ω position, a gain of 10. The output of amplifier IC1 is fed to the A to D converter.

4-9. The A to D converter consists of IC3, IC4, reference diode D5, resistors R18, R19, R20, R21, and R22, capacitors C13, C14, and C15, and a few other components. The reference voltage to the A to D converter is adjusted to 100 mV using trimmer R16. IC3 is the analog chip of the A to D converter and IC4 is the digital processor chip. The A to D converter uses the dual slope technique for analog to digital conversion. The reading is displayed by the LED numeric indicators.

4-10. POWER SUPPLIES

4-11. Diodes D16-19 and IC8 generate a +5V power supply for the A/D converter and diodes D20-D23, IC9 and IC10 generate a ± 5 V power supply for various op-amps and the A to D converter. Diodes D24-D27 and capacitor C29 are the power supply for the current source.

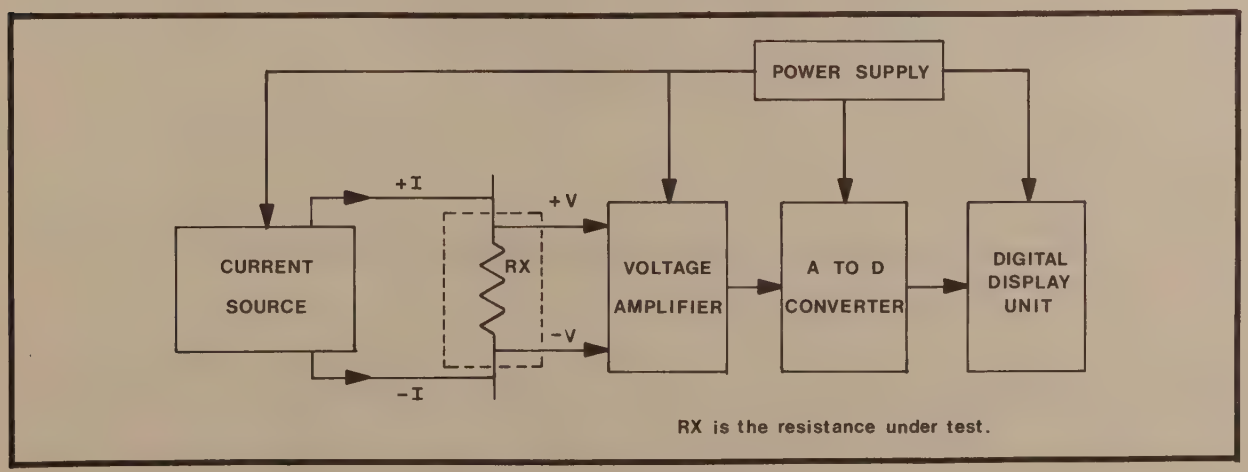


Figure 4-1. Block Diagram

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

CAUTION

Semi-conductor devices using metal oxide junctions are liable to suffer destructive damage from electrostatic discharges. Such devices appear with several names, such as MOS, MCMOS, CMOS, MOSFET, IGET, detector diode, etc. Whenever these devices or assemblies including such devices are handled, the operator must be grounded, and only grounded soldering irons can be used safely. To facilitate identification of assemblies containing metal oxide devices, Ballantine pc boards containing such devices are marked with this symbol:

SECTION 5

MAINTENANCE AND CALIBRATION

5-1. INTRODUCTION

5-2. This section contains information required to maintain the instrument within specifications. The following paragraphs detail:

a. Performance Verification Checks

b. Calibration Procedures

c. Fault Finding (Troubleshooting) Details

d. Preventive Maintenance

5-3. The instrument is designed with premium components. Like other Ballantine instruments, it will provide many years of satisfactory service. Ballantine recommends that performance verification checks and preventive maintenance procedures be performed on the following schedule:

a. Routine laboratory service every 12 months or 1,000 hours of use; whichever comes first.

b. Service in the field or in extended environments every six months or 450 hours of use; whichever comes first.

5-4. Full NBS traceable calibration should be performed once each year. Normally the user will provide recalibraton services in his plant. If required, Ballantine will gladly provide this calibration service at our Boonton, NJ service center for a nominal charge.

5-5. REQUIRED TEST EQUIPMENT

5-6. Table 5-1 provides a list of test equipment required to properly check, calibrate, and maintain the instrument. Equivalent test equipment meeting all the minimum requirements may be substituted if the recommended items are not available.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	RECOMMENDED MODEL	PURPOSE	SPECIFICATIONS
Standard Resistor (1 milliohm)	Cambridge Instrument Co.	Verify 2 mΩ range	1 mΩ ± 0.02% at 10 A; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°C
Standard Resistor (10 milliohms)	Cambridge Instrument Co.	Verify 20 mΩ range	10 mΩ ± 0.02% at 10 A; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°c
Standard Resistor (100 milliohms)	Cambridge Instrument Co.	Verify 200 mΩ range	100 mΩ ± 0.02% at 1 A; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°C
Standard Resistor (1 ohm)	Leeds and Northrup	Verify 2Ω range	1Ω ± 0.02% at 100 mA; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°C
Standard Resistor (10 ohms)	Leeds and Northrup	Verify 20Ω range	10Ω ± 0.02% at 10 mA; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°C

TABLE 5-1. RECOMMENDED TEST EQUIPMENT - Cont'd

INSTRUMENT	RECOMMENDED MODEL	PURPOSE	SPECIFICATIONS
Standard Resistor (100 ohms)	Leeds and Northrup	Verify 200Ω range	100Ω ± 0.02% at 10 mA; 4 Terminals. Temp. Coeff. of Resistor: 5 ppm/°C
4 1/2 Digit Multimeter	Ballantine Model 3036B	Fault Finding and Current Calibration	DC Voltage Range: 200 V to 200 mV Accuracy: ± 0.03% DC Current Range: 2000 mA to 20 uA with resolution of 10 nA and accuracy of 0.1%.
DC Voltage Standard	Fluke 332B	Calibration	DC Voltage: 100 V to 1 V with 100 uV resolution on 1 V range. Accuracy: ± 50 ppm of output
Oscilloscope	Ballantine Model 1022A	Fault Finding	DC to 15 MHz Dual Trace to 5 mV/DIV and Time Base of 1 us to 100 ns/DIV.

5-7. PERFORMANCE VERIFICATION CHECKS

5-8. The performance verification checks are "in cabinet" checks that compare the instrument with the applicable performance specifications. The sample performance test record, Form 5-1, may be used or duplicated to provide permanent performance test records. Beginning with incoming inspection checks, periodic performance verification checks should be made in the sequence detailed below and before any attempt is made to calibrate the instrument. The performance verification checks should also be used as part of the troubleshooting procedure and before returning the instrument to regular service after repair, recalibration, or extended storage. All checks are made at 23°C ± 2°C. Use the recommended standard resistors of Table 5-2.

TABLE 5-2. RECOMMENDED STANDARD RESISTORS

STANDARD RESISTOR	ACCURACY	MINIMUM CURRENT CAPACITY	TEMPERATURE COEFFICIENT
1 mΩ	± 0.02%	10 A	5 ppm/°C
10 mΩ	± 0.02%	10 A	5 ppm/°C
100 mΩ	± 0.01%	1 A	5 ppm/°C
1Ω	± 0.01%	100 mA	5 ppm/°C
10Ω	± 0.01%	10 mA	5 ppm/°C
100Ω	± 0.01%	10 mA	5 ppm/°C

NOTE

Prior to making any of the following performance verification checks set ac line voltage to 120 volts. Exercise each of the pushbuttons several times to clean switch contacts by self-wiping action.

a. Turn on the instrument by pushing the power ON/OFF switch after making sure that the instrument is installed as indicated in Section 2.

b. Allow 15 minutes warm up time. However, if the instrument is subjected to extremes of temperature and humidity, allow 1 hour warm up time at the specified temperature and humidity.

c. Depress the ZERO/OPERATE switch (i.e. the instrument is in ZERO/adjust mode).

d. Release mΩ/Ω switch (i.e. mΩ function is selected) and press the 2 range switch.

e. Reading shown should be .000.

f. If the reading is not .000, adjust zero by the ZERO adjust screwdriver control provided on the front panel.

g. Perform the tests detailed in Table 5-3. Use CONTinuous mode and the four wire method (as shown in Figure 3-3 of Section 3). Refer to Table 5-3 for allowable reading limits for each standard resistance.

NOTE

All standard resistors should be traceable to the National Bureau of Standards (NBS) and the readings of the instrument corrected for the actual resistance of the standard resistor.

TABLE 5-3. CALIBRATION ACCURACY CHECK

Value of Standard Resistor Connected	3205A	
	Range	Limits of Reading
1 mΩ	2 mΩ	0.995 to 1.005
10 mΩ	20 mΩ	9.95 to 10.05
100 mΩ	200 mΩ	99.7 to 100.3
1Ω	2Ω	0.997 to 1.003
10Ω	20Ω	9.97 to 10.03
100Ω	200Ω	99.7 to 100.3

h. After completing the checks of Table 5-3, connect a 1.00 mΩ resistor using the four wire method. Select 2 mΩ range of the instrument.

i. Depress PULSE/CONT switch.

j. Initiate a reading by depressing MEASURE microswitch for a fraction of a second.

k. The reading displayed should be within ± 5 counts of 1.000 mΩ. (.995 to 1.005 mΩ.)

NOTE

The reading should be held on the display for several minutes even after resistance is removed and until a new measurement cycle is initiated.

l. Repeat steps h to k. For other ranges see Table 5-3.

5-9. INTERNAL ADJUSTMENTS AND TEST POINTS

5-10. See Figure 5-1 for the location of internal adjustments and test points.

5-11. INITIAL DC POWER SUPPLY CHECKS

5-12. The instrument has no power supply adjustments but power input voltage regulation should be checked before calibration. Monitor the three regulated dc power supply voltages listed in Table 5-4 with a dc voltmeter.

TABLE 5-4. DC POWER SUPPLY LIMTS

SUPPLY	VOLTAGE LIMITS
+ 5	+ 4.3 to + 5.6
+ 15	+ 13.3 to + 16.8
- 15	- 13.3 to - 16.8

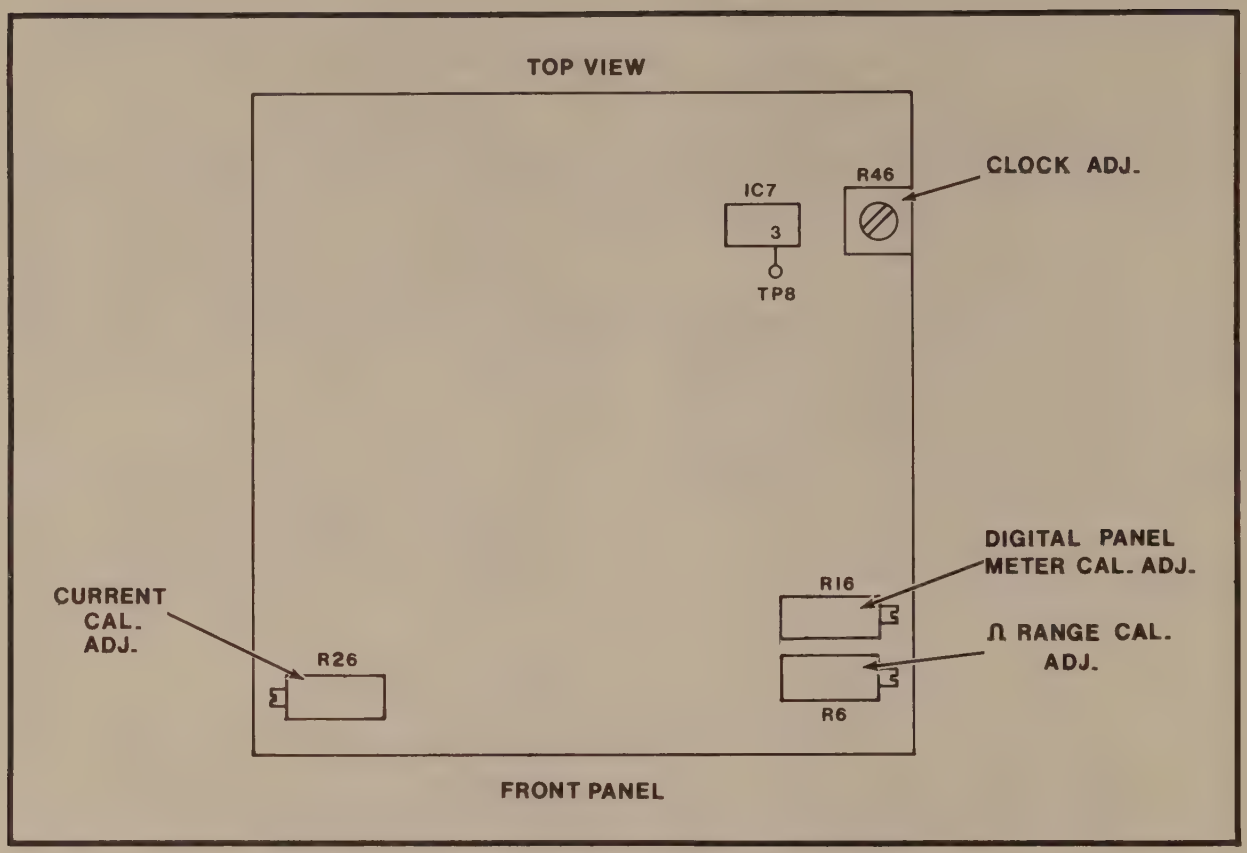


Figure 5-1. Location of Internal Adjustments and Test Points

5-13. CALIBRATION PROCEDURES

5-14. If any of the performance verification checks show an out-of-tolerance condition, recalibration will be required. Table 5-1 lists the test equipment required to completely calibrate and certify the instrument. If the instrument cannot be adjusted, refer to the troubleshooting and fault finding procedures beginning with Table 5-5.

NOTE

Only a qualified service technician with properly calibrated test equipment should service this instrument; since internal voltages may cause shock hazard. Calibrate at 23°C ± 2°C.

CAUTION

Always remove ac mains power before removing covers to avoid personnel shock hazard.

5-15. REMOVAL OF COVERS

5-16. The top and bottom covers of the plastic enclosure are fastened together by six screws, four of which are accessible through the rubber feet at the bottom cover and two are directly accessible. To remove the covers, first remove the power cord from the ac mains socket. Then, carefully over turn the instrument so that the instrument rests on its top cover. Then, remove all the six screws. Now, carefully hold the instrument so that the covers are not separated and again turn over the instrument so that the instrument rests on its bottom cover (normal position). Then, lift the top cover carefully and disengage all plastic vertical spacers (6 each) between top and bottom covers. Keep the top cover set aside. The handle may now be removed and stored separately. Now the front panel, rear panel, display assembly, etc. are free of support and may be removed.

5-17. PRELIMINARY INSPECTION

5-18. The instrument should be inspected occassionally for such defects as broken connections, loose, broken or frayed wiring, dirty or pitted switch and connector contacts, and cracked or broken printed circuit boards. Often, before a partial or total failure occurs, a deteriorating

component may be identified by obvious discoloration, cracking, or warping. Care must be exercised when heat damaged parts are located. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine actual cause of overheating before the heat damaged part is replaced, otherwise the damage may be repeated. Always replace components with exact equivalents to be certain that all performance specifications can be obtained. Use heat shunts when soldering diodes and semiconductors. Do not overheat circuit board printed wiring and pads.

NOTE

Always perform the calibration in the sequence indicated below.

5-19. CALIBRATION OF CURRENT SOURCE (Current Cal. Adj. R26)

a. Connect the current leads of the 3205A to the current input terminals of the multimeter. The range selected on the multimeter should be able to measure 100 mA current.

b. Select 20 mΩ range of the instrument and release ZERO/OPERATE switch (i.e. put the instrument in the OPERATE mode).

c. Using the adjustment potentiometer marked as R26, current calibration on the circuit diagram, adjust the current to 100 mA ± 0.05 mA.

d. Select 200 mΩ range of the instrument and select proper multimeter range to measure 10 mA current. The current should be in the range of 9.99 mA to 10.01 mA.

e. Select 2 Ω range of the instrument. The current should be within the range of 9.99 mA to 10.01 mA.

f. Select 20 Ω range of the instrument and select proper current range of the multimeter to measure 1 mA of current. The current should be within the range of 0.999 mA to 1.001 mA.

g. Select 200 Ω range of the instrument and select proper current range of the multimeter to measure 100 uA of current. The current should be within the range of 99.90 uA to 100.10 uA.

h. Select the proper current range of the multimeter to measure 1 A current. Select 2 mΩ range of the instrument. The current should be within the range of 0.999 A to 1.001 A.

5-20. CLOCK ADJ. (R46)

a. Connect a frequency counter to pin 3 of IC7. This is TP8.

b. Adjust the counter to properly trigger and set it to measure frequency on the 1 sec time base.

c. Adjust R46 until the counter reads 100,000 Hz ± 50 Hz.

d. Connect a 1 ohm standard resistor to the 3205A.

e. Set the 3205A controls to:

Ω, 2, CONT

f. Note the displayed resistance reading.

g. Set the 3205A to PULSE mode and push the MEASURE pushbutton to obtain a resistance reading. Note this reading.

h. The CONT reading of step f and the PULSE readings of step g should be equal ± 2 LSD. If necessary, adjust R46 while repeating steps d and e until the resistance readings are the same.

5-21. DIGITAL PANEL METER CALIBRATION (R16) and Ω RANGE CAL. ADJ. (R6)

a. Connect the dc voltage source to the voltage leads of the instrument. Set for CONT mode.

b. Select 2 mΩ range of the instrument and use the screwdriver ZERO control to zero the DPM.

c. Release ZERO/OPERATE switch (i.e. put the instrument in OPERATE mode).

d. Apply a voltage of 1.9 mV from the dc voltage standard.

e. Using the preset potentiometer R16, adjust the display of the instrument to read 1.900.

f. Remove the applied voltage and select 20 Ω range of the instrument.

g. Apply a voltage of 19 mV from the dc voltage standard.

h. Using the adjustment potentiometer marked as R6 on the schematic diagram, adjust the display of the instrument to read 19.00.

5-22. After calibration is performed, it is necessary to check the accuracy using standard resistances. For this purpose, follow the performance verificaton checks given in paragraph 5-7.

5-23. TROUBLESHOOTING AND FAULT FINDING

5-24. The troubleshooting procedures should only be performed when the instrument can not be calibrated with the calibration procedures listed in paragraph 5-13 thru 5-21. Should the instrument be inoperative or out of specification, follow the fault finding procedures detailed below.

5-25. This section deals with the various faults which may be observed during the useful life of the instrument. Included are the probable causes and possible remedial actions for these faults.

5-26. Carefully examine the instrument and check for any visual evidence of trouble. Check for broken wires, burnt resistors, loose components, shorts, or open or defective solder joints on the printed circuit board. Check for separation of printed circuit board tracks and pads. Check for open, defective, or intermittent switches. Check that connectors are clean and will mate properly.

5-27. Understand and be familiar with the circuit theory of operation as explained in Section 4. Use the block diagram (Figure 4-1) and the schematic diagram (given in Section 6) to isolate the probable circuit areas which may cause the problem. Always check the power supply voltage. Now, follow the procedures given below to service the instrument.

5-28. See the following Fault Finding Tables to locate faults.

a.	Power Supply	Table 5-5
b.	Current Source	Table 5-6
c.	Voltage Amplifier	Table 5-7
d.	Active Filter	Table 5-8
e.	Digital Panel Meter	Table 5-9
f.	Clock Oscillator	Table 5-10
g.	Display	Table 5-11
h.	PULSE Mode Operation	Table 5-12

TABLE 5-5. FAULT FINDING - POWER SUPPLY

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Mains fuse blows repeatedly.	Short in primary side.	Check wiring of primary circuit and correct as required.
	Short in primary winding.	Replace transformer if primary winding resistance is less than approximately 100 ohms.
2. Transformer overheats.	Short in the secondary circuit.	Check the voltages of all secondaries. The secondary with short circuit will show very low voltage than normal voltage. Normal ac voltages are: Orange-Orange: 10 V rms Yellow-Blue-Yellow: 20 - 0 - 20 V rms Black-Black: 10 V rms
3. Shorted secondary (Black-Black).	Shorted diode D16, D17, D18, D19.	Check and replace.
	Shorted C23.	Check and replace.
	Short in the secondary.	Replace the transformer.
4. Shorted secondary (Yellow-Blue-Yellow).	Shorted diodes D20, D21, D22, D23.	Check and replace.
	Shorted C27, C28.	Check and replace.
	Short in the secondary.	Replace the transformer.
5. Shorted secondary (Orange-Orange).	Shorted diodes D24, D25, D26, D27.	Check and replace.
	Shorted C29.	Check and replace.
	Short in the secondary.	Replace the transformer.
6. Voltage between Pin 1 and Pin 15 of IC4 is below 5 ± 0.25 V or is not obtainable.	ON/OFF switch connection open. Check switch pin number.	Check and correct.
	Faulty IC8.	Check and replace.
	Shorted C24.	Check and replace.
7. Voltage between Pin 8 and Pin 5 of IC3 is below 15 ± 0.6 V or is not obtainable.	ON/OFF switch connection open.	Check the switch and correct.
	Shorted C27.	Check and replace.
	Faulty IC9.	Check and replace.
8. Voltage between Pin 1 and Pin 5 is below -15 ± 0.6 V, or is not obtainable.	ON/OFF switch connection open.	Check the switch.
	Shorted C28.	Check and replace.
	Faulty IC10.	Check and replace.

TABLE 5-6. FAULT FINDING - CURRENT SOURCE

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Current source not working.	1 Amp fuse blown.	Replace 1 Amp fuse.
	Open connections in circuit due to breaking of wire.	Check for continuity as per schematic diagram and correct as required.
	Faulty transistors Q1 and Q2.	Check and replace.
	Faulty IC5.	Check for voltages as shown below. If not satisfactory, replace IC5. Short the current leads. POINTS — VOLTAGE Pin 3 to 4 of IC5. — 1 V Pin 7 to 4 of IC5. — 8 V (approx.) Pin 6 to 4 of IC5. — 2.5 V to 3 V (approx.) E of Q1 — 1 to 1.5 V Pin 2 to 4 of IC5. — 1 V exact
2. 1 Amp current is not obtainable.	Open collector of Q2.	Check continuity between C of Q2 and +ve of C29 and correct.
	Open R28.	Check and replace.
	The contacts of 2 range switch open.	Refer to schematic diagram, check, and correct.
	The contacts of mΩ switch open.	Refer to schematic diagram, check, and correct.
3. 100 mA current is not obtainable.	Open R31.	Check and replace.
	The contacts of 20 range switch open.	Refer to schematic diagram, check, and correct.
	The contacts of mΩ switch open.	Refer to schematic diagram, check, and correct.
4. 10 mA current is not obtainable.	Open R34.	Check and replace.
	The contacts of 20 range switch open.	Refer to schematic diagram, check, and correct.
	The contacts of mΩ/Ω switch open.	Check and correct referring to schematic diagram.
5. 1 mA current is not obtainable.	Open R37.	Check and replace.
	The contacts of 20 range switch open.	Refer to schematic diagram, check, and correct.
	The contacts of Ω switch open.	Refer to schematic diagram, check, and correct.
6. 100 uA current is not obtainable.	Open R40.	Check and replace.
	Contacts of 200 range switch open.	Refer to schematic diagram, check, and correct.
	Contacts of Ω switch open.	Refer to schematic diagram, check, and correct.
7. Current source working but there are oscillations.	Open/Faulty C17.	Check and replace.

TABLE 5-7. FAULT FINDING - VOLTAGE AMPLIFIER

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Not able to get zero in mΩ range.	Offset voltage of IC1 might have gone high.	See if zero can be obtained by changing R7 and R9 so that the total of R7, R8, and R9 is approximately 250 K.
2. No output (Other Ranges).	Discontinuity in the circuit due to some open component.	Refer to schematic diagram, check, and correct.
	Faulty components R2, R3, R4, R5, R6, etc., C3, C4, etc.	Check and replace if necessary.
	Faulty IC1.	Check and replace if necessary.
3. ZERO output.	R1 open.	Check and replace.
	D1 and D2 short.	Check and replace.

TABLE 5-8. FAULT FINDING - ACTIVE FILTER

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. Pick up and noise not bypassed.	Faulty components like C5, C6, R13, R14.	Check and replace.
	Faulty IC2.	Check and replace.

TABLE 5-9. FAULT FINDING - DIGITAL PANEL METER

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. When voltage terminals are shorted and instrument is in Ω/mΩ range, display shows over-ranging instead of showing zero.	Active filter not by-passing the pick up and noise.	Confirm by isolating the filter. If faulty, follow the procedure given in table 5-8.
	Faulty R20, R17, R18, C13, C14, C15, Q3 and Q4, R15, R16, R17.	Check for values and continuity. Replace if necessary.
	Faulty SIC3, SIC4.	Check and replace if necessary.
2. Same as 1 above where display shows some reading other than zero.	Faulty C14.	Check and replace if necessary.
	Faulty R21, R22, D8, D9.	Check for values and continuity. Replace if necessary.
	Faulty SIC4.	Check and replace if necessary.
3. When input is varied from 0 to 200 mV, DPM indicates linearly up to a certain voltage and then tends to saturate.	Faulty R20/C13.	Check, correct, and replace if necessary.
	Faulty clock frequency.	Adjust clock frequency with R46 to obtain 100 kHz.
4. More than one count flicker in display. Reading not stable.	Active filter not by-passing pick up and noise.	Check as per procedure in table 5-8.
	Supply voltages not clean.	Check supply voltages as per table 5-5. Ripple should be less than 5 mV.
	Faulty C15.	Check and replace.

TABLE 5-10. FAULT FINDING - CLOCK OSCILLATOR

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. No output at Pin 3 of IC7.	Faulty components i.e., R45, R46, R47 C19, C20, etc.	Check R45, R46, R47, C19 and C20 for proper values and replace if necessary.
	IC7 faulty.	Check and replace.
	SIC3 loading IC7.	Remove SIC3 and check waveform. If obtained, check SIC3 and related interconnections between SIC3 and IC7. Check if it is shorted to any other circuit track. If yes, correct.
2. Clock can not be adjusted to 100 kHz.	Faulty components C19, R45, R46, R47	Check for correct values and connections. Replace if necessary.

TABLE 5-11. FAULT FINDING - DISPLAY

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. All LEDs are dark.	+5 V supply not connected to display.	Check as per schematic diagram and correct. Check connector.
	Digit drive signals absent at bases of transistors Q102 to Q105.	Check for the continuity of connections from Pins 19, 24, 25, 26 of SIC3 to bases of transistors Q102 to Q105. Correct if necessary and also check for digit drives on IC3.
	Faulty Q102 to Q105.	Check and replace.
	Faulty IC101.	Check for a, b, c, d, e, f, g outputs of IC101. All of them should not be at one level when Pin 4 is at 1 level. Replace IC101 if necessary.
2. Display is dark when it reads zero.	Transistor Q107 faulty.	Check the signal at collector of Q107. It should be an inverted form of the signal at Pin No. 9 of SIC3. Replace Q107 if necessary.
3. One or more segments of one LED dark.	Faulty LED.	Check connections and voltage level(s) for these segment(s). If all are okay, then replace LED.
4. One or more segments of all LEDs are dark.	Corresponding drives of IC101 (out of a, b, c, d, e, f, g) are faulty.	Check for proper connections and voltage levels. If all are okay, replace IC101.
5. One LED is dark.	See fault 1 above.	See fault 1 above.
6. One or more binary codes missing.	Faulty SIC3.	Check for binary code at pins 20, 21, 22, 23. If code is not correct, replace SIC3.
	Faulty IC101.	Check for proper connections from pins 20, 21, 22, 23 of SIC3 to IC101. If they are okay, replace IC101.
7. One LED is brighter than normal and all others off.	Faulty clock oscillator.	Follow the procedures given in Table 5-10.
8. Decimal point not lighting.	The decimal points are not getting grounded when corresponding switches are pressed.	Check the connections as per the schematic diagram for proper grounding through resistances.
	Faulty LED.	Check and replace.
9. One or both function LEDs are not lighting (Ω/mΩ indicator LEDs).	Open connection in the corresponding switch.	Check and correct.
	Faulty LEDs.	Check and replace.

TABLE 5-12. FAULT FINDING - PULSE MODE OPERATION

FAULT	PROBABLE CAUSE	CORRECTIVE ACTION
1. PULSE mode readings are different from CONTinuous mode readings.	Clock frequency.	Connect resistance to be measured in CONT mode and note the reading. Now switch to PULSE mode and note the reading. If the reading is different, adjust clock frequency using R46 to get same displayed resistance reading.

5-29. PREVENTIVE MAINTENANCE

5-30. CLEANING. The instrument should be cleaned as often as operating conditions require. Thoroughly clean both the inside and outside of the instrument. Remove dust from inaccessible areas with low pressure compressed air or vacuum cleaner. Use alcohol applied with a cleaning brush to remove accumulations of dirt or grease from connector contacts and component terminals. Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth.

5-31. REPAIR AND REPLACEMENT. Repair and replacement of electrical and mechanical parts must be accomplished with care and caution. Printed circuit component boards can become warped, cracked, or burnt from excessive heat or mechanical stress. The following repair techniques are suggested to avoid inadvertent destruction or degradation of parts and assemblies.

a. Use a low-heat capacity soldering iron (Weller Model No. W-TCP 35 watt) with a 700°F tip 1.5 mm (1/16") to 2.5 mm (3/32") wide.

b. Be sure that the soldering iron tip and the cabinet and COMMON connectors are securely tied to "earth" ground. This avoids possible overvoltage damage to semiconductors and capacitors.

c. To desolder components, use a commercial "solder sipper", (SOLDA PULLT manufactured by Edsyn Products or equivalent) or use solder-removing SODER-WICK, size 3, manufactured by SOLDER REMOVAL CO., Covina, California.

d. To remove a component, clip a heat sink such as long nose pliers, tweezers, or alligator clips onto the component lead and as close to the body of the component as possible. This assures minimum heating of the component while soldering.

e. Place the soldering iron directly on the component lead on the printed circuit conductor side of the board. Use a desoldering aid to remove all solder and free the component lead. Straighten the bent over component lead with long nose pliers. Pull the component out of the hole. If a component is obviously faulty or damaged, simply clip the leads close to the body of the component and remove the remaining leads through the conductor side of the printed circuit board.

CAUTION

ALWAYS USE SHORT SOLDERING CYCLES SINCE EXCESSIVE OR PROLONGED HEAT MAY DESTROY THE LAMINATE BOND AND LIFT THE COPPER CONDUCTORS FROM THE PRINTED CIRCUIT BOARD AND CAUSE IMMEDIATE DEGRADATION OR LATENT DAMAGE TO THE COMPONENTS.

f. Always clean the component lead holes by heating the solder on the circuit board conductor pad, then quickly remove the soldering iron and insert a printed non-metallic object such as a toothpick to clean the hole. Never solder cover the hole, since the incoming new component lead may then push the pad from the circuit board.

g. To install a new component, straighten and shape the leads. Insert the component into the proper holes. Bend the leads at the conductor side of the circuit board so that they fall over the pad and extend over the foil of the incoming conductor path. Cut the bent lead approximately 2.5 mm from the hole. Clip a heat sink to the component lead at the body of the component. Heat the lead and pad with a soldering iron and use fresh solder as required to cover the lead and form a meniscus over the hole to assure a good electrical connection.

h. Clean excess flux from the connection and surrounding area. Use appropriate cleaning solution and a clean soft brush to clean board and components.

NOTE

Do not touch cleaned board or excessively handle components to avoid unwanted leakage which may affect performance when exposed to high humidity.

i. Always replace a component with its exact duplicate as specified in the parts list.

Ballantine

PERFORMANCE VERIFICATION TEST RECORD

MODEL 3205A, OPTION _____ SERIAL NUMBER _____

1. 120 Volt mains ZERO adjust (Paragraph 5-8e) [.000] _____

2. Calibration Accuracy Check (Paragraph 5-8g) CONT MODE

STANDARD RESISTOR AT INPUT	RANGE	LIMITS OF READING	READING
1mΩ	2mΩ	0.995 to 1.005	
10mΩ	20mΩ	9.95 to 10.05	
100mΩ	200mΩ	99.7 to 100.3	
1Ω	2Ω	0.997 to 1.003	
10Ω	20Ω	9.97 to 10.03	
100Ω	200Ω	99.7 to 100.3	

3. Calibration Accuracy Check (Paragraph 5-8k,e) PULSE MODE

STANDARD RESISTOR AT INPUT	RANGE	LIMITS OF READING	READING
1mΩ	2mΩ	0.995 to 1.005	
10mΩ	20mΩ	9.95 to 10.05	
100mΩ	200mΩ	99.7 to 100.3	
1Ω	2Ω	0.997 to 1.003	
10Ω	20Ω	9.97 to 10.03	
100Ω	200Ω	99.7 to 100.3	

4. Readings are retained for > 60 seconds after resistance is removed or until new cycle is initiated (Paragrph 5-8k). _____(✓)

5. Check Options when required

   Option 01 - BCD Output _____(✓)

   Option ___ _____(✓)

   Option ___ _____(✓)

6. Mechanical Checks _____(✓)

_____ _____

TEST ENGINEER DATE

FORM 5-1

SECTION 6
PARTS LIST & CIRCUIT DIAGRAMS

The replacement parts listed are available from the vendors listed or from Ballantine Laboratories. Your local Ballantine Field Engineering Representative may also carry a stock of parts and can assist you. If pricing quotations are required for parts and or repairs your local representative will give the most rapid service or you may contact the Ballantine Factory directly.

When ordering replacement parts always give the following information:

a) Instrument Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification and description of part

Ballantine will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of the components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The instrument may substitute alternate components but the use of parts specified in this parts list is recommended. A part similar to the part initially installed at the factory may be used, i.e., a 5% composition resistor may be replaced with a similar part or a 5% film resistor or the preferred 1% metal film resistor. Use of the preferred component will always simplify calibration and speed repairs.

Any selected component is generally identified in this manual and may be replaced with a similarly valued part unless reselection is required due to replacement or change of its related part. The schematics and calibration procedures identify selected components and replacement procedures.

The Manufacturer Code is taken from Federal Supply Code Cataloging Handbooks H4-1, H4-2, and H4-3. Ballantine Code is 50423.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWC	Switch
LMP	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CCW) type N-55, N-60 and C-32. Allen Bradley carbon composition resistors type EB may also be used but should generally be avoided (except for emergency replacements) in favor of the preferred part listed in this parts list.

PARTS LIST, MODEL 3205A MAIN PCB ASSEMBLY A1 (89-61306-1A)

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
A1. J2	48-10007-0A	SOC 16 PIN SOLDER TAIL	01295	TI 016ST-7520(TABOR)
A1. J3	31-10253-0A	CON MTA-100 POST 5 PIN	00779	AMP 640098-5
A1. S1	25-60300-0A	SWC 7 STAGE GANGED SWITCH	50423	BLI
A1. S2	25-60301-0A	SWC MOM. SWITCH TWO-POLE	50423	BLI
C...1	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C...2	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C...3	07-10613-0A	CBM 100.0NF 100V 10%	80031	MEPCO 708B1LE104PK101AX
C...4	07-10613-0A	CBM 100.0NF 100V 10%	80031	MEPCO 708B1LE104PK101AX
C...5	07-10614-0A	CBM 1.0 UF 100V 10%	80031	MEPCO 708B1VT105PK101AX
C...6	07-10614-0A	CBM 1.0 UF 100V 10%	80031	MEPCO 708B1VT105PK101AX
C...7	07-10562-0A	CCR 0.1 UF 50V .3 SPACE	04222	AVX CERAMICS MD015E104ZAA
C...8	07-10562-0A	CCR 0.1 UF 50V .3 SPACE	04222	AVX CERAMICS MD015E104ZAA
C..10	07-09573-0A	CCD 330 PF 500 V K 10%	71590	CTL TYP CE-331
C..11	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C..12	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C..13	07-10615-0A	CBM 220.0NF 100V 10%	80031	MEPCO 708B1LL224PK101AX
C..14	07-10614-0A	CBM 1.0 UF 100V 10%	80031	MEPCO 708B1VT105PK101AX
C..15	07-10267-0A	CYM 10.0UF 63.0 VK POLYSTER	52763	STET-TRUSH MKT1822-610/06
C..16	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C..17	07-09561-0A	CCD 1 NF 1 KV K 10%	84171	ARC TYP CCS-102
C..18	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..19	07-10441-0A	CBM 10.0NF 400.0 V	80031	MEPCO 719B1CA103PJ401SA
C..20	07-10331-0A	CCD 10.0NF 50.0 V +-20%	71590	CTL UK-50-103
C..21	07-07847-0A	CEA 10 UF 16 V T	73445	AMPEREX C426AR/E10
C..22	07-10616-0A	CBM 2.2 UF 100V 10%	80031	MEPCO 701B1SJ225PK101SX
C..23	07-07833-0A	CEA1000.0UF 16.0 VT	73445	AMPEREX C437AR/E1000
C..24	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..25	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..26	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..27	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..28	07-10617-0A	CEA 100.0UF 40V -10+50%	80031	MEPCO 3073FE101T040JPA
C..29	07-10618-0A	CEA 4700 UF 25V -10+50%	80031	MEPCO 3074MK472T025JPB
C..30	07-10331-0A	CCD 10.0NF 50.0 V +-20%	71590	CTL UK-50-103
C..31	07-10562-0A	CCR 0.1 UF 50V .3 SPACE	04222	AVX CERAMICS MD015E104ZAA
D...1	10-10205-0A	TRQ 2N4392	04713	MOT/NAT/FCH 2N4392
D...2	10-10205-0A	TRQ 2N4392	04713	MOT/NAT/FCH 2N4392
D...3	05-09477-0A	DZG 1N5231A 5.1 .5W 20M 10%	04713	MOT SI D07
D...4	05-09477-0A	DZG 1N5231A 5.1 .5W 20M 10%	04713	MOT SI D07
D...5	24-10421-0A	ICP ICL 8069	32293	INTERSIL ICL8069CCQ
D...8	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
D...9	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
D..10	05-60171-0A	DGP 3BR200 DUAL DIODE TO220	50423	BLI
D..11	05-60171-0A	DGP 3BR200 DUAL DIODE TO220	50423	BLI
D..13	24-10421-0A	ICP ICL 8069	32293	INTERSIL ICL8069CCQ
D..14	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
D..15	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
D..16	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..17	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..18	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..19	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..20	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..21	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..22	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..23	05-09472-0A	DGP 1N4002 100 1A	04713	CSD1 05-09472-0A MOT SI D041
D..24	05-10063-0A	DRP 1N5400 50 3A	04713	MOT SI
D..25	05-10063-0A	DRP 1N5400 50 3A	04713	MOT SI
D..26	05-10063-0A	DRP 1N5400 50 3A	04713	MOT SI
D..27	05-10063-0A	DRP 1N5400 50 3A	04713	MOT SI
HTS.1	49-10046-0A	HTS HEATSINK FOR MOT CASE 77	30161	AAVID ENG.#5307B-14
IC..1	24-10422-0A	ICP ICL 7650 CHOPPER AMP	32293	INTERSIL ICL7650CPD
IC..2	24-10156-0A	ICP LM741CN OP. AMP	12040	NATL. SEMI LM741CN
IC..3	24-10423-0A	ICP ICL 8068 A/D CONV.	32293	INTERSIL ICL8068ACPD
IC..4	24-10424-0A	ICP ICL 7103 A/D CONV.	32293	INTERSIL ICL7103ACPI
IC..5	24-10140-0A	ICP CA3140T OP AMP FET TO-8	86684	RCA CA31407
IC..6	24-10087-0A	ICP NE555 TIMER DIP 8 PIN	32293	INTERSIL OR EQUIV
IC..7	24-10087-0A	ICP NE555 TIMER DIP 8 PIN	32293	INTERSIL OR EQUIV
IC..8	24-10153-0A	ICP UA7805 5V REG.	07263	FAIRCHILD UA7805UC
IC..9	24-10152-0A	CIP UA7815 15V REG.	07263	FCH UGH7815393
IC.10	24-10228-0A	ICP 7915 15V NEG REG TO-220	04713	MOT MC7915CP O/E
Q...1	10-10052-0A	TRQ 2N3053A NPN 1 50 MTO-5	86684	RCA 1 100M 50
Q...2	10-60206-0A	TRQ BC 109	50423	BLI
Q...3	10-60206-0A	TRQ BC 109	50423	BLI
R...1	12-06161-1A	RFW 18.0 K 5.0 W J+- 5%	50423	BLI
R...2	12-06178-0A	RFW 900.0 250.0MW A+-.2%	54294	SHC TYP P10
R...3	12-12129-0A	RFF 20.0 250.0MW F+- 1%	16299	RN55D 20R0 F
R...4	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R...5	12-13174-0A	RFF 9.09K 250.0MW F 50PPM	80031	MEPCO RN55C
R...6	09-10288-0A	RVF 2.0K CERMET 20T	80294	BOURNS 3006P-1-202
R...7	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R...8	09-10289-0A	RVF 50.0K CERMET 20T	80294	BOURNS 3006P-1-503
R...9	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R..10	12-12617-0A	RFF 1.50M 500 MW F+-1%	16299	CGW RN60D 1504 F
R..11	12-01112-0A	RFC 470.0 500.0MW J+- 5%	01121	A-B TYP EB
R..12	12-01112-0A	RFC 470.0 500.0MW J+- 5%	01121	A-B TYP EB

PARTS LIST, MODEL 3205A MAIN PCB ASSEMBLY A1 (89-61306-1A) - CONT'D

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
R..13	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R..14	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R..15	12-12364-0A	RFF 4.64K 250.0MW F+- 1%	16299	CGW RN55D 4641 F
R..16	09-10290-0A	RVF 500.0 CERMET 20T	80294	BOURNS 3006P-1-501
R..17	12-12472-0A	RFF 56.2 K 250.0MW F+- 1%	16299	CGW RN55D 5622 F
R..18	12-13165-0A	RFF 10.0 K 250.0MW F 25PPM	80031	MEPCO RN55E
R..19	12-12492-0A	RFF 90.9 K 250.0MW F+- 1%	16299	CGW RN55D 9092 F
R..20	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R..21	12-12450-0A	RFF 33.2 K 250.0MW F+- 1%	16299	CGW RN55D 3322 F
R..22	12-12546-0A	RFF 301.0 K 250.0MW F+- 1%	16299	CGW RN55D 3013 F
R..23	12-12429-0A	RFF 20.0 K 250.0MW F+- 1%	16299	CGW RN55D 2002 F
R..24	12-12417-0A	RFF 15.0 K 250.0MW F+- 1%	16299	CGW RN55D 1502 F
R..25	12-12308-0A	RFF 1.21K 250 MW F+-1%	16299	CGW RN55D 1211 F
R..26	09-10290-0A	RVF 500.0 CERMET 20T	80294	BOURNS 3006P-1-501
R..27	12-12384-0A	RFF 7.50K 250.0MW F+- 1%	16299	CGW RN55D 7501 F
R..28	12-63349-0A	RFW 1.0 OHM 2W 0.1%	50423	BLI
R..31	12-63350-0A	RFW 10.0 OHM 1/2W 0.1%	50423	BLI
R..34	12-63351-0A	RFW 100.0 OHM 1/4W 0.1%	50423	BLI
R..37	12-63352-0A	RFW 1.0K OHM 1/4W 0.1%	50423	BLI
R..40	12-63353-0A	RFW 10.0K OHM 1/4W 0.1%	50423	BLI
R..43	12-13283-0A	RFF 100.0 K 250.0MW F 25 PPM	80031	MEPCO RN55E
R..44	12-09289-0A	RCF 10.0 500.0MW J+- 5%	73445	AMP TYP
R..45	12-12372-0A	RFF 5.62K 250.0MW F+- 1%	16299	CGW RN55D 5621 F
R..46	09-10291-0A	RVF 5.0K CERMET 1T HORZ. MTG.	11236	CTS 370U-5K 30%
R..47	12-12329-0A	RFF 2.0 K 250.0MW F+- 1%	16299	CGW RN55D 2001 F
R..48	12-08023-0A	RFC 2.2 K 250.0MW J+- 5%	01121	A-B TYP CB
R..49	12-12572-0A	RFF 562.0 K 500.0MW F+- 1%	16299	CGW RN60D 5623 F
RL..1	14-60043-0A	RLY REED FORM 1A 5V	50423	BLI
XI.C1	48-10006-0A	SOC 14 PIN DIP SOLDER TAIL	01295	TI #C831402
XI.C3	48-10006-0A	SOC 14 PIN DIP SOLDER TAIL	01295	TI #C831402
XI.C4	48-10028-0A	SOC 28 PIN DIP LOW PROFILE	91506	AUGAT 228-AG39D

PARTS LIST, MODEL 3205A DISPLAY BOARD ASSEMBLY A2 (89-61307-1A)

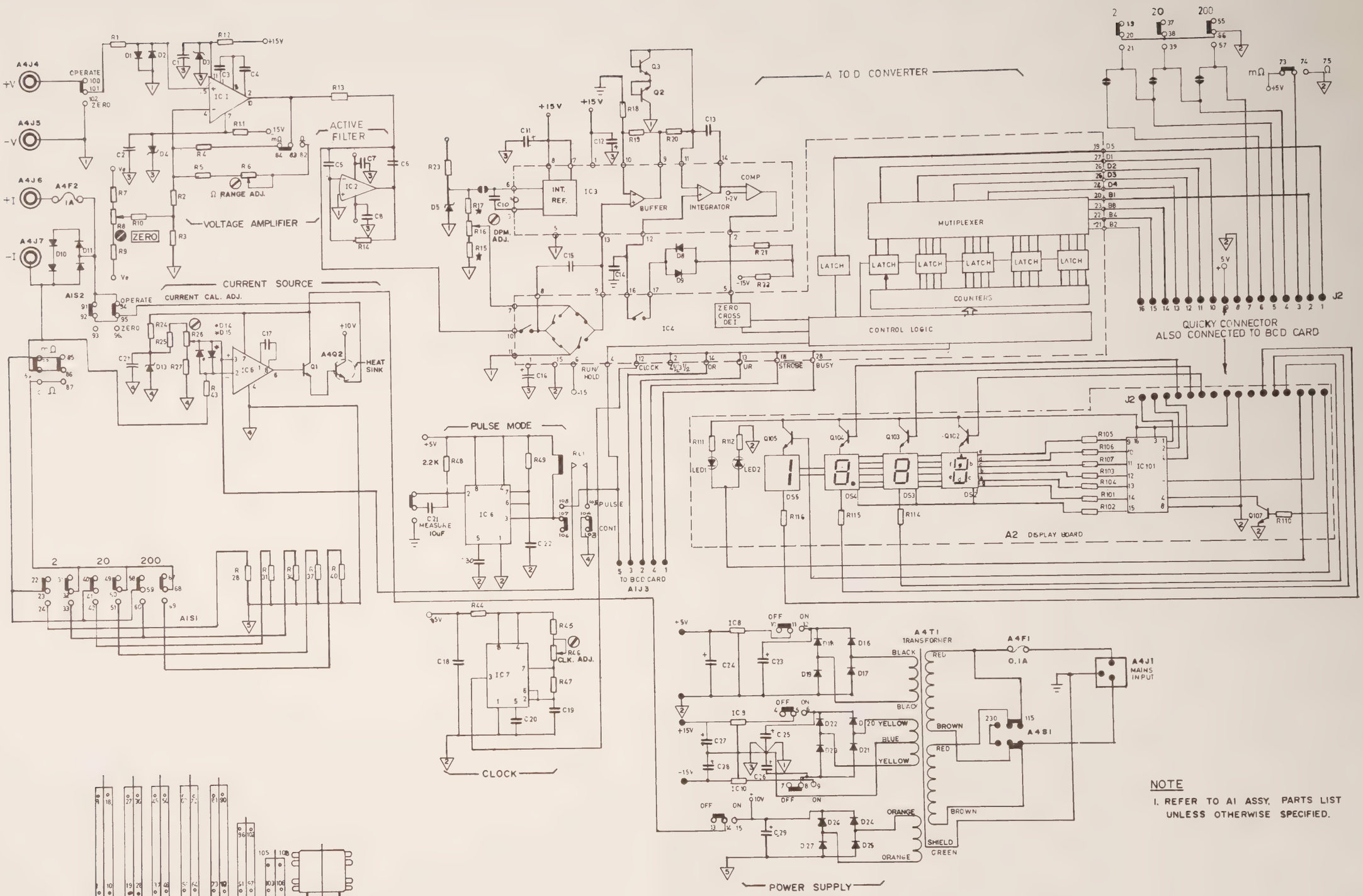
SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
DS..2	21-10069-0A	IND 7SEG DISPLAY COM ANODE	07263	FND507/TIL321/MAN6660
DS..3	21-10069-0A	IND 7SEG DISPLAY COM ANODE	07263	FND507/TIL321/MAN6660
DS..4	21-10069-0A	IND 7SEG DISPLAY COM ANODE	07263	FND507/TIL321/MAN6660
DS..5	21-10070-0A	IND +-1 DISPLAY COM ANODE	07263	FND508/TIL330/MAN6630
IC101	24-10095-0A	ICP 7447 7 SEG DRIV FOR LED	27014	NAT-SEMI DM7447AM OR EQV
LED.1	16-10028-0A	LMP LED RED WIDE ANGLE	28480	HP 5082-4655
LED.2	16-10028-0A	LMP LED RED WIDE ANGLE	28480	HP 5082-4655
Q.102	10-10203-0A	TRQ 2N4970 NPN	04713	MOT/NAT/FCD 2N4970
Q.103	10-10203-0A	TRQ 2N4970 NPN	04713	MOT/NAT/FCD 2N4970
Q.104	10-10203-0A	TRQ 2N4970 NPN	04713	MOT/NAT/FCD 2N4970
Q.105	10-10203-0A	TRQ 2N4970 NPN	04713	MOT/NAT/FCD 2N4970
Q.107	10-10005-0A	TRQ MPS6515 NPN 1 25 PTO-92	04713	MOT MPS6515
R.101	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.102	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.103	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.104	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.105	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.106	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.107	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.110	12-08014-0A	RFC 47.0 K 250.0MW J+- 5%	01121	A-B TYP CB
R.111	12-09805-0A	RFC 120.0 250.0MW J+- 5%	01121	A-B TYP CB
R.112	12-09805-0A	RFC 120.0 250.0MW J+- 5%	01121	A-B TYP CB
R.114	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.115	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB
R.116	12-08019-0A	RFC 47.0 250.0MW J+- 5%	01121	A-B TYP CB

PARTS LIST, MODEL 3205A FINAL ASSEMBLY A4 (89-61309-1A)

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
A4..A	44-60046-0A	FEE 3205A RUBBER FOOT	50423	BLI
A4..B	51-60180-0A	COV 3205A TOP COVER	50423	BLI
A4..C	51-60181-0A	COV 3205A BOTTOM COVER	50423	BLI
A4..D	51-60182-0A	COV 3205A TRANSISTOR COVER	50423	BLI
A4..E	53-60139-0A	SHD 3205A CASE SHIELD	50423	BLI
A4.F	65-10021-0A	INS CHOMERICS TO-3 INSULATOR	18565	CHOMERICS 60-11-4511-1671
A4.F1	19-10063-0A	FUS 0.25A 20MM FAST ACTING	75915	LITTLEFUSE 212.250
A4.F2	19-10062-0A	FUS 1.0A 20MM FAST ACTING	75915	LITTLEFUSE 212001

PARTS LIST, MODEL 3205A FINAL ASSEMBLY A4 (89-61309-1A) - CONT'D

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
A4. J1	31-60366-0A	CON 3205A AC MAINS CONN.	50423	BLI
A4. J4	74-60042-0A	TRM 3205A TERMINAL RED	50423	BLI
A4. J5	74-60042-0A	TRM 3205A TERMINAL RED	50423	BLI
A4. J6	74-60043-0A	TRM 3205A TERMINAL BLACK	50423	BLI
A4. J7	74-60043-0A	TRM 3205A TERMINAL BLACK	50423	BLI
A4. Q2	10-10204-0A	TRQ 2N3055 NPN TO3	04713	MOT/NAT/TI 2N3055A
A4. S1	25-60302-0A	SWC 3205A AC LINE SEL. SWITCH	50423	BLI
A4. T1	20-60080-0A	TRX 3205A TRANS ASSY.	50423	BLI
A4FH1	19-60061-0A	FSH 3205A FUSE HOLDER 20MM	50423	BLI
P...2	88-10133-1A	CAA 3205A DISPLAY CABLE	50423	BLI



NOTE

1. REFER TO A1 ASSY. PARTS LIST UNLESS OTHERWISE SPECIFIED.

Figure 6-1. Model 3205A, Schematic Diagram

SECTION 7

OPTIONS AND ACCESSORIES

7-1. OPTION 01 - Parallel BCD Output.

7-2. INTRODUCTION

7-3. The BCD output card provides digital measurement information to a rear panel output connector for the use for data printers, digital comparators, etc.

7-4. SPECIFICATIONS

AVAILABLE DATA:	Digits, Polarity, Decimal points and +5 V supply and ground.
DATA CODING:	8-4-2-1 BCD parallel.
LOGIC LEVELS:	1 = +5 V 0 = 0 V
DRIVE CAPABILITY:	All outputs can drive a maximum of 1 TTL load.
POWER SUPPLY:	+5 V can source only 50 mA maximum.

7-5. CONNECTOR

7-6. Use a 44 pin PC edge to 44 pin ribbon cable connector, Ballantine P/N 31-10365-0. The 44 pin cable is Ballantine P/N 79-10133-0.

7-7. PIN CONNECTIONS A3J1

DATA NAME	PIN NO.	REMARKS
Sign	22	1 is -Ve, 0 is +Ve
Decimal point 3	44	0 represents DP activated
Decimal point 2	43	0 represents DP activated
Decimal point 5	20	0 represents DP activated
Decimal point 4	19	0 represents DP activated
A5	41	Most significant digit
A4	40	A is the LSB (2^0)
B4	39	B is the NLSB (2^1)
C3	38	C is the NLSB (2^2)
C4	37	D is the NLSB (2^3)
D4	36	Refer to schematic diagram for details
B3	35	Refer to schematic diagram for details
D3	34	Refer to schematic diagram for details
A3	33	Refer to schematic diagram for details
D2	10	Refer to schematic diagram for details
A2	9	Refer to schematic diagram for details
C2	30	Refer to schematic diagram for details
B2	29	Refer to schematic diagram for details
B1	28	Refer to schematic diagram for details
C1	27	Refer to schematic diagram for details
D1	26	Refer to schematic diagram for details
A1	3	Refer to schematic diagram for details
+5 V	24	Refer to schematic diagram for details
-Ve	23	Refer to schematic diagram for details

NOTES

1. For a 3½ digit display, the last digit i.e., D1 will be blanked and will be active only in case of a 4½ digit instrument. For a 3½ digit instrument, A1, B1, C1, D1 will be all at 0 level.

2. All other pins of 44 pin connector do not have any connections.

PARTS LIST, MODEL 3205A BCD BOARD OPTION 01
A3 ASSEMBLY (89-61308-1A)

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
A3. J1	31-10365-0A	CON 44PIN CARD EDGE	15912	ANSLEY 609-4405M
A3. J2	48-10007-0A	SOC 16 PIN SOLDER TAIL	01295	TI 016ST-7520(TABOR)
A3. J3	31-10253-0A	CON MTA-100 POST 5 PIN	00779	AMP 640098-5
C. 401	07-10331-0A	CCD 10. ONF 50. 0 V +-20%	71590	CTL UK-50-103
C. 402	07-10331-0A	CCD 10. ONF 50. 0 V +-20%	71590	CTL UK-50-103
D. 401	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
D. 402	05-07920-0A	DGP 1N4148 75 10M	07263	FCH SI D035
IC401	24-10254-0A	ICP MC14011 QUAD NAND	04713	MOT 14 PIN DIP
IC402	24-10254-0A	ICP MC14011 QUAD NAND	04713	MOT 14 PIN DIP
IC403	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC404	24-10270-0A	ICP 14001 QUAD NOR GATES	04173	MOT 14001 OR EQUAL
IC406	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC407	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC408	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC409	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC411	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC412	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC413	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC414	24-10420-0A	ICP CD4042BE	86684	RCA/MOT/TI CD4042BE
IC415	24-10419-0A	ICP CD4009UBE	86684	RCA/MOT/TI CD4009UBE
IC416	24-10419-0A	ICP CD4009UBE	86684	RCA/MOT/TI CD4009UBE
IC417	24-10419-0A	ICP CD4009UBE	86684	RCA/MOT/TI CD4009UBE
P. . . 2	88-10131-1A	CAA 3205A BCD/DISPLAY CABLE	50423	BLI
P. . . 3	88-10132-1A	CAA 3205A BCD 5 PIN CABLE	50423	BLI
R. 401	12-08003-0A	RFC 100. 0 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 402	12-08011-0A	RFC 10. 0 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 403	12-08016-0A	RFC 1. 0 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 404	12-08031-0A	RFC 2. 7 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 405	12-08024-0A	RFC 3. 3 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 406	12-08024-0A	RFC 3. 3 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 407	12-08024-0A	RFC 3. 3 K 250. 0MW J+- 5%	01121	A-B TYP CB
R. 408	12-08024-0A	RFC 3. 3 K 250. 0MW J+- 5%	01121	A-B TYP CB

NOTE

For instruments using Option 01, cable assembly 88-10133-1A must be replaced with cable assembly 88-10131-1A.

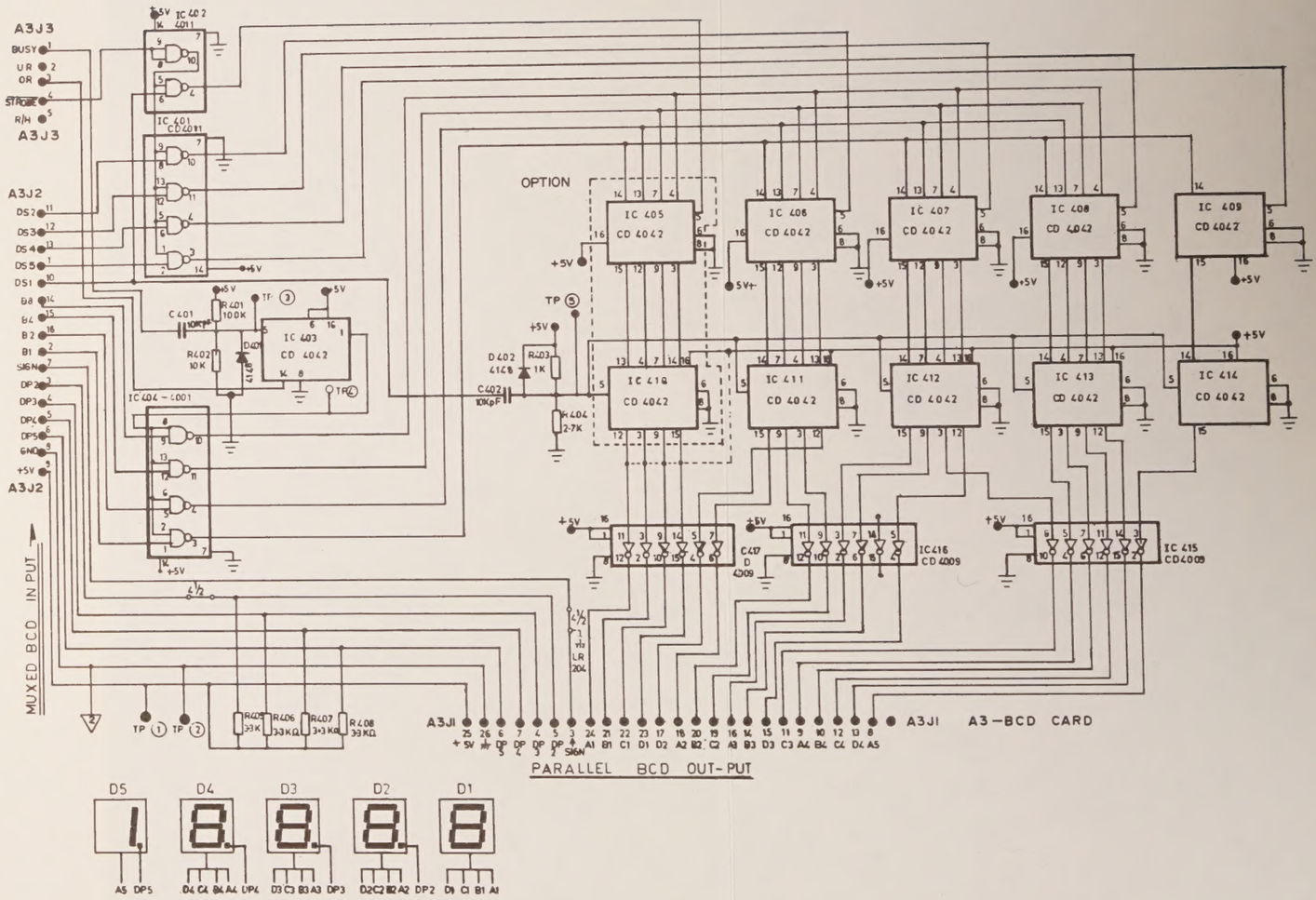


Figure 7-1. Option 01 BCD Schematic Diagram

LITTLE MOUNTAIN

MP MASTER
MA31988

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